TESTING FOR AIR POLLUTION

U.S. DEPARTMENT OF AGRICULTURE Science Study Aid No. 5

TEACHER'S INTRODUCTION

Air pollution is a problem for most Americans. Whether they live in a rural or urban area, their environment is affected by pollutants in the atmosphere.

The three experiments in this Science Study Aid are designed to provide the teacher with some basic air pollution activities. The first experiment involves particulates, the second deals with microorganisms, and the third looks at gases in the atmosphere.

The experiments give students an opportunity to observe the presence of pollutants in their own environment. They will see pollutants which will always be a part of the air they breathe—such as microorganisms. And they will find other pollutants, such as particulates and acid gases.

The experiments are written so that you may reproduce them for distribution directly to your students if you wish.

Testing for Air Pollution was developed by Miss Artice Dunbar, an elementary-science specialist with the District of Columbia Public Schools, working with scientists at the U.S. Agricultural Research Center, Beltsville, Md.

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EXPERIMENT I: Air Particle Test

Introduction

Solid particles of such things as soot, dust, and pollen are sometimes suspended in the air we breathe. They come from fuel combustion, construction projects, and harvesting operations, plus a host of other manmade and natural sources. Eventually these particles are inhaled by men and animals, fall into water supplies, or settle on surfaces as dust or sometimes thick grime.

Some kinds of these particles, or particulates, can make men and animals sick. Some foul water supplies, and others blacken buildings and coat windows with sludge.

Objective

To collect, observe, and test particulate matter from the atmosphere.

Materials

Filter paper
Balance or laboratory scales
Glass jar or beaker
Distilled water
Magnifying glass
Tape and thumb tacks
pH tester - litmus paper (or universal pH indicator paper)

Procedure

1. Record the weight of each piece of filter paper you plan to use.
2. Select one or more exposure sites for the filter paper; any place where dust collects will do. Weigh any tape used to secure the filter paper at the exposure site.
3. After 3 to 7 days weigh the filter paper again. Note any increase in weight or change in color of the paper (fig. 1).
4. Use the magnifying glass to note the different sizes, colors, and shapes of particles collected on the filter paper.
5. Put some distilled water in a beaker or jar. Test the pH of the water and save the litmus paper.
6. Rinse the particles off the filter paper into the beaker and observe the particles with a magnifying glass.
7. Test the pH of the water with the particles suspended in the water. Compare the litmus paper to that used to test the distilled water in Item 5. Save both litmus papers.
8. Obtain a sample of particulate from a source such as an air conditioner or furnace filter. Rinse the particles into another beaker of distilled water. Observe what happens to the particles, check the pH, and compare the litmus papers.

Discussion Questions

1. Did you find evidence of air pollution particulates in your own environment?
2. Did you find that in a short time a significant buildup of particles can occur, even on a small piece of filter paper?
3. Do particulates differ in size, shape, and color?
4. Although particulates remain suspended in the atmosphere, do they differ in density and solubility?
5. Does particulate matter from a home filter hold acid chemical compounds which will dissolve in water?

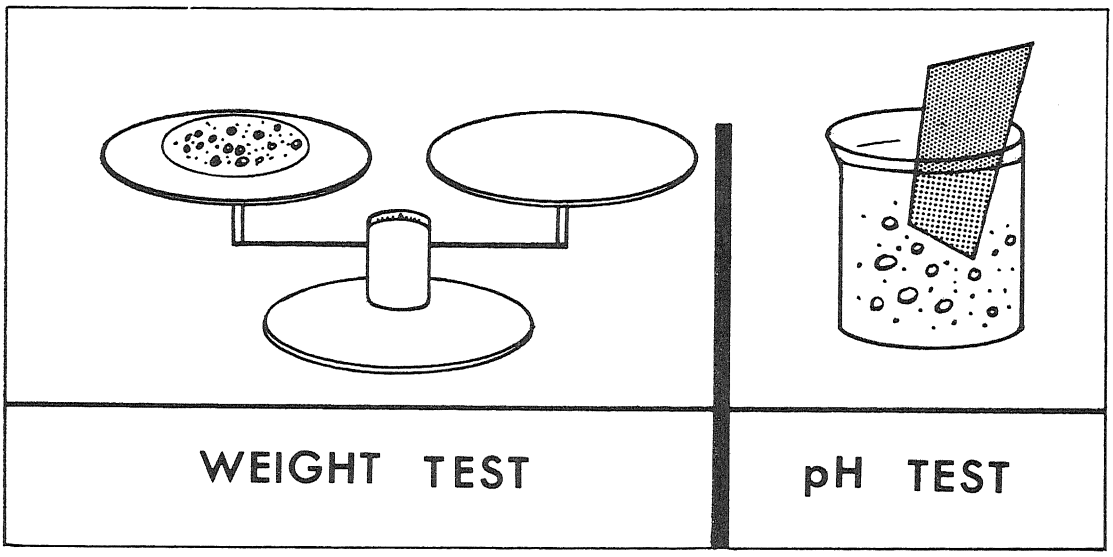

Figure 1.—Weighing filter paper and testing pH of water.

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EXPERIMENT II: Testing for Microorganisms

Introduction

The air we breathe is filled with living cells called microorganisms. Although their presence in the atmosphere is not out of place, microorganisms are pollutants.

Some microorganisms are disease bearing. Others pass through the body system of men, plants, and animals every day without causing any harm.

Objective

To collect, grow, and observe different kinds of microorganisms present in the atmosphere.

Materials

10 sterile petri dishes—or sterilized, shallow, clear jars may be used
About 200 ml. of nutrient agar—such as potato dextrose
Magnifying glass
Thermometer
An incubator—or any place where the temperature can be maintained at 25° to 35° C. (77° to 95° F.) for 24 hours. The temperature used should be recorded.

Procedure

1. Melt the agar and cool it to about 45° C. (113° F.).
2. Pour 15 to 20 ml. of agar into each petri dish. Depending on their size, the jars may need slightly more agar. Cover the dishes immediately.
3. Expose each dish to a different air sample for 15 to 30 minutes. Use sites where there is a free flow of air, such as a windowsill, or a place near a fan or ventilation inlet. Also cough directly on one dish two or three times. Breathe on another dish for about 3 minutes. Cover all dishes immediately after exposure.
4. Incubate for 24 hours at 25° to 35° C (77° to 95° F). Colonies of microorganisms should begin to grow on the agar.
5. Observe the microorganisms and record the data on a chart like the one shown in figure 2. Show the totals in the form of a bar graph.

Discussion Questions

1. Is there a variation in the number of colonies that develop in the agars, depending on the exposure site?
2. Do the dishes exposed to human microorganisms show the most colonies?
3. Is there a difference in the color of the colonies in each dish? What would cause this effect?
4. Do the colonies differ in size and shape? Why?

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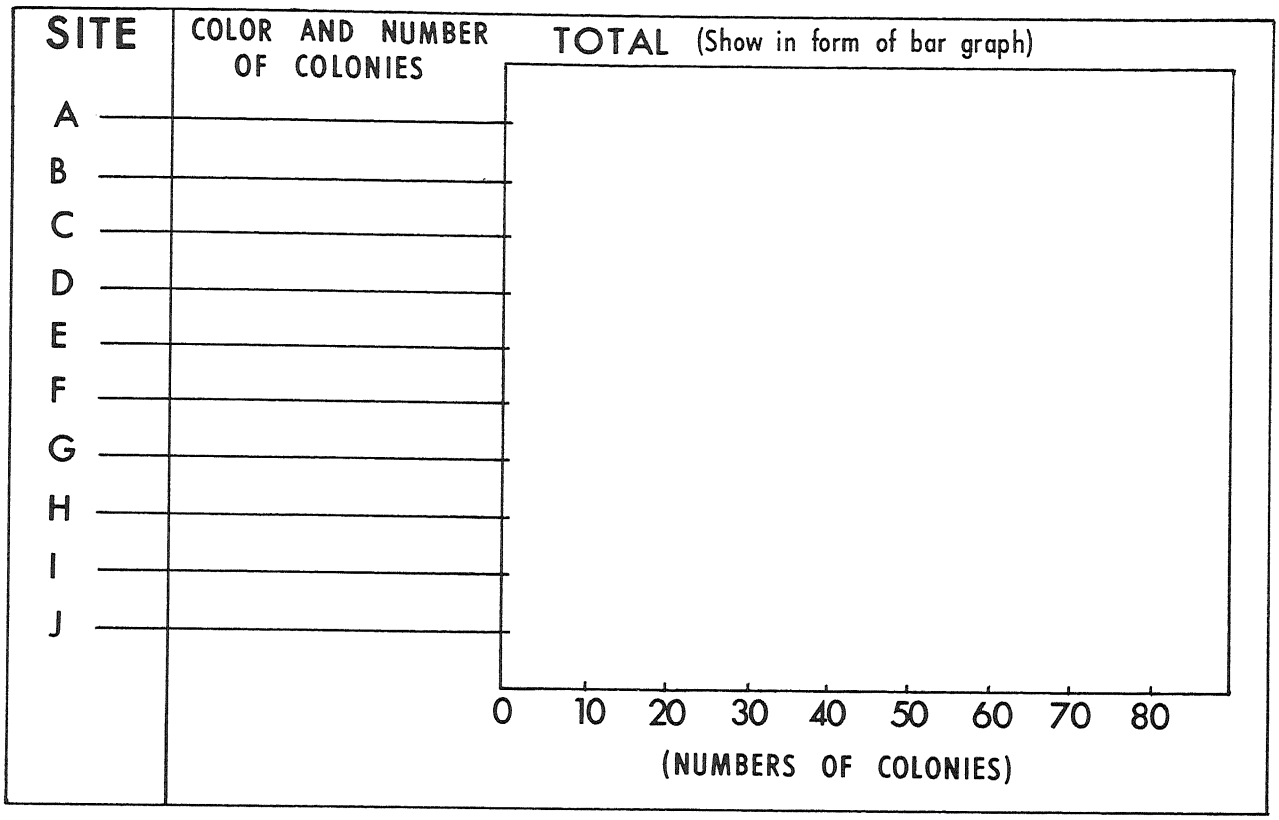

Figure 2.—Chart and graph for Experiment II.

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EXPERIMENT III: Testing for Acid Air

Introduction

Acid gases are prime ingredients of urban air pollution. These gases may damage plants, corrode metals, crumble stone, and in heavy concentration they can sicken men and animals.

Objective

To test air samples for their acid content.

Materials

A large funnel.
An air pump or aspirator—most pet shops sell air pumps.
Filter papers—one for each exposure site, large enough to cover the large end of the funnel.
Tape to hold filter paper on funnel.
One ounce of 0.01 M sodium bicarbonate solution.
One ounce of 0.1-percent methyl orange indicator—pH 1-3.
One ounce of glycerin.
Two or three ounces of a dilute solution of 10-percent hydrochloric acid in a beaker.
Three eye dropper bottles.
Two or three feet of rubber or glass tubing.
Chart and graph.

Procedure

1. Cut filter paper big enough to fit over the large opening of the funnel with a 1/2-inch overlap. Tape it on.
2. Add a drop of glycerin to the center of the paper.
3. Add a drop of the indicator solution to the center of the paper. More drops may be necessary if the color is not apparent.
4. Add a drop of sodium bicarbonate solution to the center of the paper.

   NOTE: Support the filter paper with a piece of wire screen cut to fit over the opening of the tunnel if the moistened paper cannot withstand the flow of air through it without rupturing. Place the screen on the funnel, then place the paper over it. Secure both with tape or a rubber band.

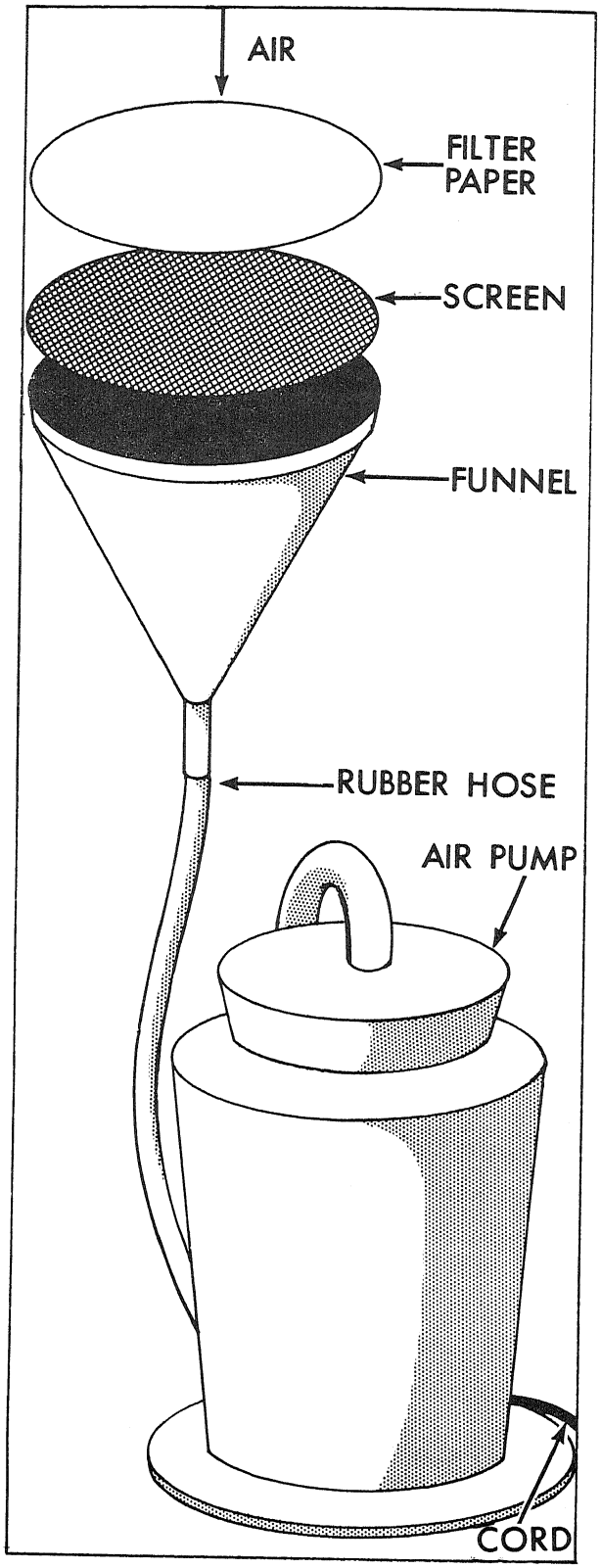

Figure 3.—Equipment setup for Experiment III.

5. Attach the tubing to the small end of the funnel and to the air pump.
6. Start the air pump and the timer. Do a preliminary test, drawing air from above the open bottle of dilute hydrochloric acid. Stop the pump when a red color is visible.
7. Test some air:
   a. Drawn from a chemistry laboratory.
   b. In a chemistry storeroom.
   c. Outdoors.
   d. In a kitchen.
   e. From exhaled breath.
   f. From the exhaust of an automobile.
   g. From any other source you can think of.
8. Make a record of the results on a chart and bar graph to illustrate the presence of acid gases at the test sites. Record on the chart the site location, the time you started taking the air sample, and the time the treated filter paper began to react with the gases (fig. 4). Show the elapsed time figures in the form of a bar graph. Then you will have a complete picture of the acid gas concentrations encountered in the test.

Discussion Questions

1. Are acid gases present in the air?
2. Do gas concentrations differ, depending on the source and the air circulation at the exposure site?
3. What are the possible sources of acid gases which could account for the reactions observed?

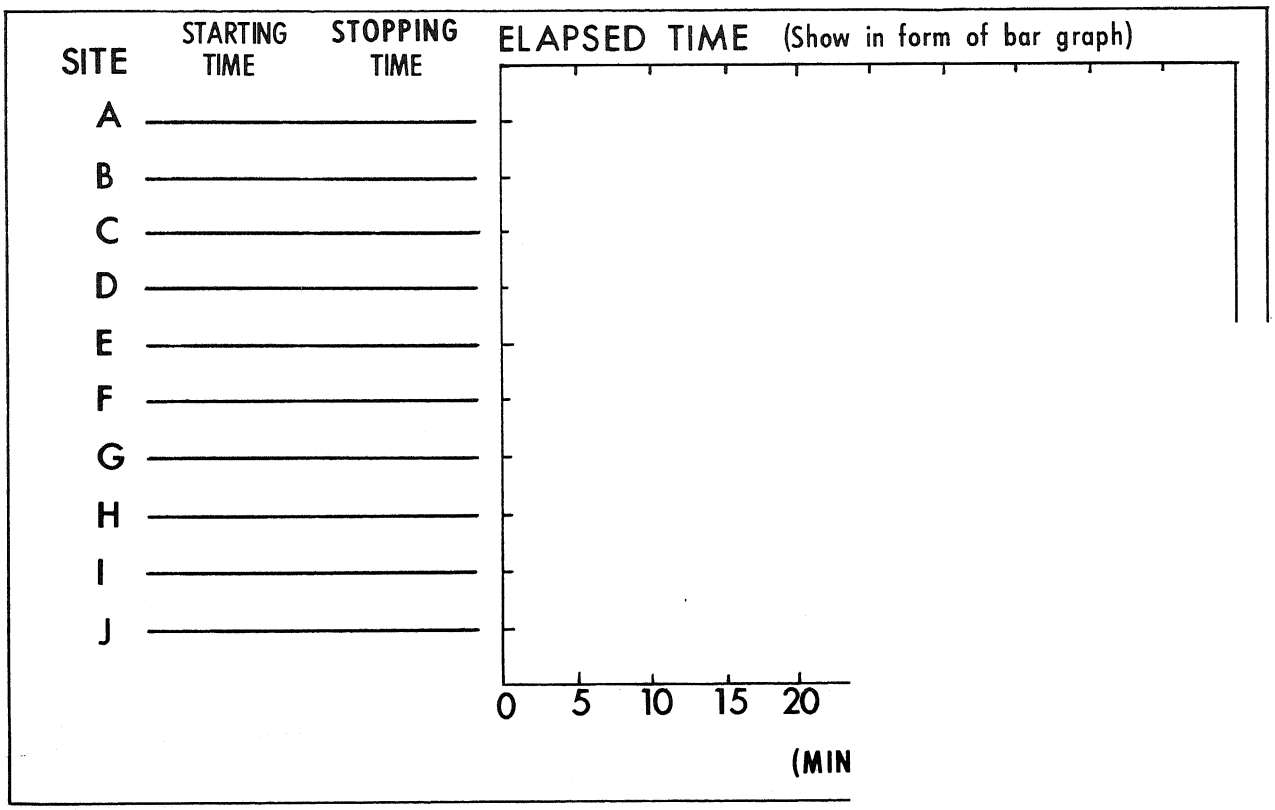

Figure 4.—Chart and graph for Experiment III

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